Gas Journal

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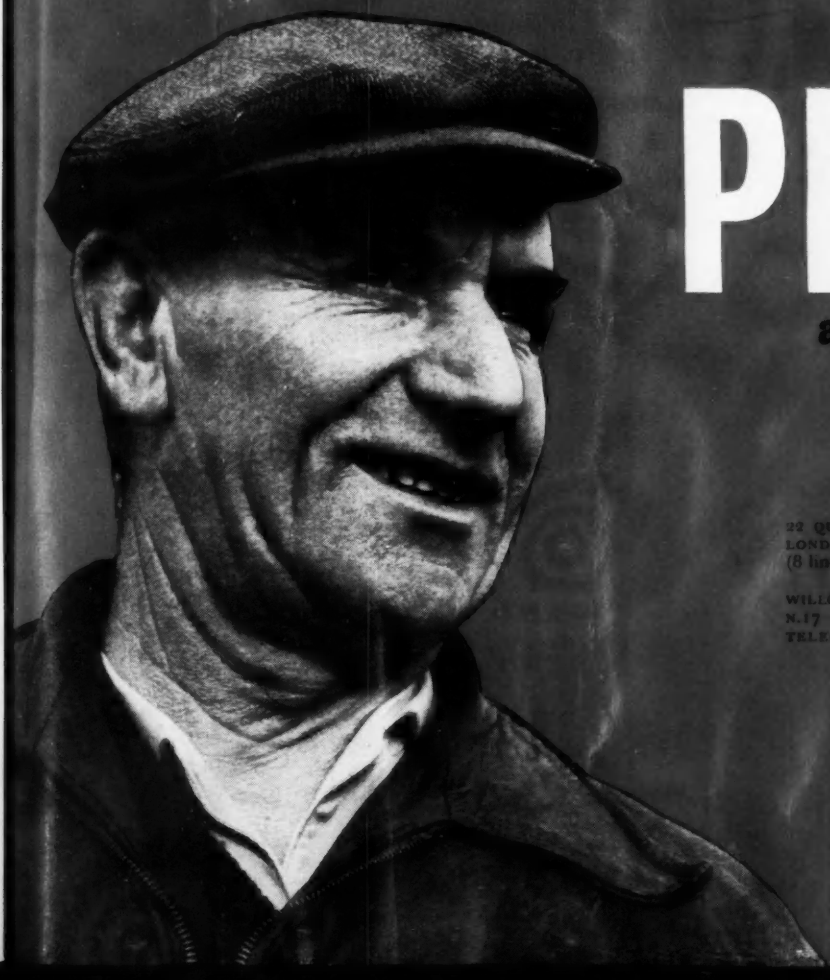

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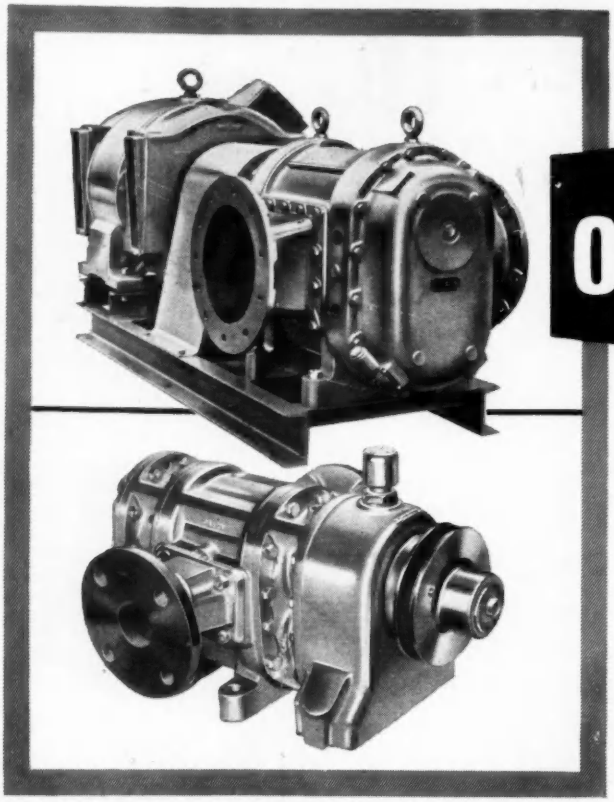

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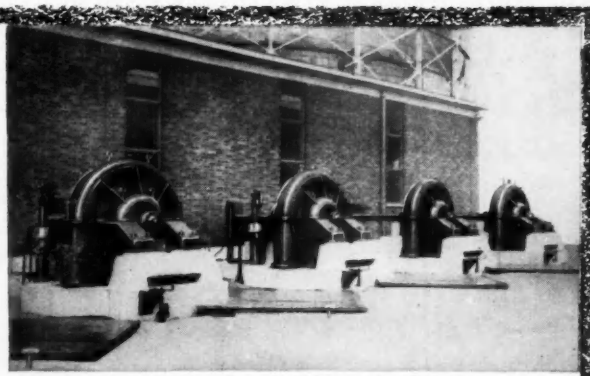

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Gas Journal

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CONTENTS

EDITORIAL COMMENT

Chemicals, By-products and the Future - - 291

CHEMICAL AND BY-PRODUCT SURVEY

Introduction by W. K. Hutchison - - - - 293
Two Centuries of By-products. By E. G. Stewart - 294
Recovery of Benzole from Coal Gas. By Thornton Scott - - - - - - - - - 300
Goodyear 'Cures' Rubber by an Accident. By M. Schofield - - - - - - - - 307

BOOK REVIEW

B.S.I.'s Report for 1959-60 - - - - - 308

NEWS SUPPLEMENT

200 French Flats Will Employ Se-Duct - - - 309
Swedes Choose N.W.G.B. Coke - - - - 309
Oil Heater Makers Fulfil Pledge - - - - 309
N.Z. Gasholder Will be Built in U.K. - - - 309
C19th Cottages Modernise with Gas - - - 310
Sahara Gas for Germany - - - - - 310
Natural Gas Find at Roma - - - - - 310
RoSPA Prepares for Operation Cleansweep - - 310
Dundee Gasworks May Close - - - - 311
Two Men Lift 16-ton Engine - - - - - 311
B.B.C. TV Shows Gas-heated Greenhouse - - 311
Personal - - - - - - - - - 312
Obituary - - - - - - - - - 312

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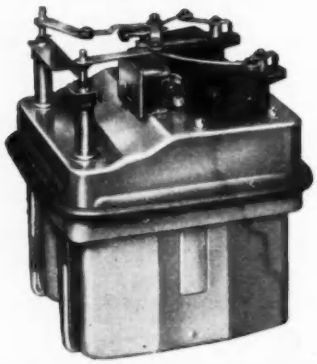

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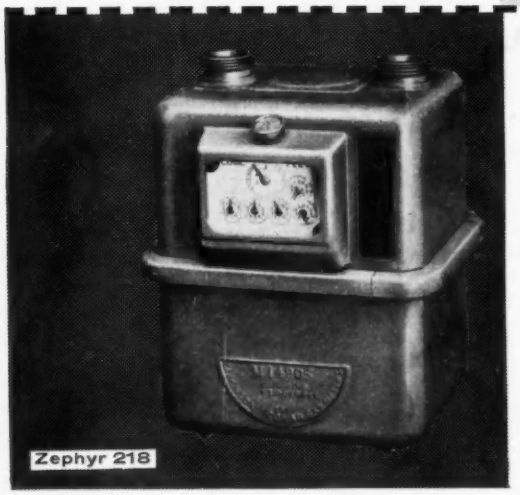

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Gas Journal

COKE OVENS • BY-PRODUCTS • CHEMICALS

Chemicals, by-products and the future

THE recovery of by-products resulting from the carbonisation process has changed over the years not only in method but in emphasis. To both the gas and coking industries chemicals and by-products are a matter of great importance because the prices of the two fuels are sensitive to the market value of the by-products, whether sold as crude material or worked up into refined products by gas and coke oven plants, or by the large co-operative tar distillers.

We believe that the time has come for a detailed and comprehensive review of the whole situation. The special articles which appear in this, and succeeding issues, of the 'GAS JOURNAL,' are intended to illustrate the field covered by the profitable disposal of these substances which, because of the nature of the material and processes employed to make the main product, must, of necessity, be produced as side issues.

Whatever may be the aim of any industry in which by-products are produced, their disposal will always constitute a serious factor, not only in the economics of production, but even in the possibilities of survival of the industry itself. In cases where the sale, either of the crude by-products or of their refined derivatives, can be made to yield a profit, such revenue will lower the price at which the main product can be sold in a competitive market. In other cases—as, for example, where undesirable effluents or noxious impurities are produced, or where sufficient storage cannot be found on the producers' ground—it may be necessary to provide means of disposal solely with the object of ensuring the continuity of production of the main product. An example of this is gas liquor, which, rather than being a source of net revenue, presents a problem in disposal.

A study of the by-product situation in the gas and fuel industries presents an extremely complex problem on account of the inter-relationship of such industries with one another, and with the chemical and metallurgical industries and the production of power. Here we can find many instances where the by-products of one industry may become the raw materials of another, and where a by-product is called upon to justify its use, both in respect of quality and price, in competition with raw material obtainable from other sources.

In our series of special articles, there has been no intention to separate the parts played by gasworks and coke ovens in the production of by-products, since both those industries use the same raw material and employ, basically, the same process for its treatment, although each is directed towards the manufacture of its own main product; in the former case to the production of town gas, and in the latter to the making of metallurgical coke. Owing to differences in carbonising conditions, and, to a lesser extent, in coal characteristics, the yields and qualities of the by-products differ somewhat in the two cases, the tar distillates obtainable from coke ovens having, in general, a higher content of aromatic components and naphthalene, and leaving more and harder pitch than the corresponding products obtained from steamed vertical retorts at gasworks. Other types of tar are also produced from gasworks making carburetted water gas or where oil-cracking is practised. The implementation of the Lurgi process for gasmaking in this country in the near future will lead to the production of its own special range of by-products.

Although coke is not to be considered as the chief objective in the gas industry, it is not dealt with here as a by-product, since, notwithstanding the position which it occupied 30 or 40 years ago, it should not now be regarded as a residual arising from the gas-making process. The advent of the Clean Air Act has firmly established the production and sale of solid fuels from selected coals, carefully prepared and screened for specific purposes in various markets.

The provisions of the Gas Act require, as a duty, that all area gas boards shall develop and maintain the efficient, co-ordinated and economical production of coke, and shall also develop and maintain efficient methods of recovering by-products.

It is evident that the gas industry, at its present stage, must therefore regard itself as a two-fuel industry, and that, under its obligation as to by-products, it has great potentialities in the field of supply of chemical products.

Status of by-products

On the question of the status of gasworks and coke oven by-products, there are two powerful influences at work. The first of these is the effect of competition from other sources of chemicals. There is an encouraging tendency on the part of the large chemical manufacturing firms in this country to develop the production of pure chemicals which are used as the basis for making synthetic materials such as plastics, synthetic rubber, refrigerants, anæsthetics, solvents, medical products, and a wide range of materials used for special trades. These are, in a large degree relatively simple substances which it is only practicable to make from either coal or oil. The establishment of large petroleum refineries in Great Britain during the past few years has led to severe competition with coal tar products for the production of such substances, and it is from this quarter that the greatest difficulties might be expected in the profitable disposal of residuals from the carbonisation of coal.

Changing pattern

The other factor to be taken into account is the changing pattern of the gas industry which has been brought about by new methods of gas production, the use of hitherto unconventional sources of gas-making materials, and the integration of small undertakings into larger manufacturing stations feeding grid systems. These changes are still going on, and will continue to have their influence on the by-products status for at least another ten or 15 years.

In the field of new gas-making methods, we are using increasing amounts of petroleum products ranging from gas oil to heavy fuel oil, and there is cause for uneasiness in relying too much on imported products which may become scarcer and dearer. The use of coals of types hitherto considered unsuitable for normal carbonising plant is being implemented to a certain extent in conventional gas retorts. It seems likely that economy in capital and labour costs, coupled with the highest efficiency of conversion of coal or oil into gas in very large works units will come about within the next few years by the introduction of processes now under development for gasifying oil or coal under high pressure. Such processes, which may or may not involve the use of catalysts, are amenable to very considerable variations in yield and type of products by appropriate regulations of the conditions under which the reactions are allowed to take place. New methods of purification will be incorporated to reduce the sulphur content of the gas to a very low figure, and considerable control will be possible over the proportion of carbon dioxide and carbon monoxide in the gas. The new techniques will create a new set of by-products for which markets will have to be found.

While all this is in the future, carbonisation by conventional means will have to continue for several years in existing gas retort installations. There is no process as yet which can produce base-load gas as cheaply as an efficient carbonising plant which already exists, i.e., ignoring capital charges, but, with present coal prices and difficulties in obtaining the right types, there is little or no inducement to install new retorts involving very high capital costs to meet increases in the demand for gas. But here again the obligation to provide solid smokeless fuel comes into the picture and we have to pause to think, just as we must consider deeply before introducing any method of increasing gas output which will reduce the amount of coke available for sale (e.g., water gas production).

N.C.B. monopoly?

It may, perhaps, be permissible to visualise a more distant future state when the gas industry, producing gas as its one main product, will cease to make solid fuels. In such a case the manufacture of these is likely to be the concern almost, if not entirely, of the National Coal Board, and would be coupled with a far greater production of chemical products than heretofore by the integration of the chemical industry with coal, a state of affairs already visualised by Dr. Bronowski.

How do these considerations affect the attitude which has to be taken by the gas industry toward the by-products question? What stands out prominently is the realisation of the changes which are taking place in the status of by-products. These changes exert their effect on general policy and are showing us that what is profitable today may be a debit tomorrow, or *vice versa*. Prevailing circumstances are leading us to embark on new ventures in gasworks practice, and each one of these is liable to create its own special problem in respect of its by-products.

Future trends

It behoves the industry, therefore, to be wide awake as to what is going on in the chemical trades, and to fit its disposal programme into the general scheme as profitably as possible, always keeping an eye on future trends which may not have been sufficiently well explored in the past.

A high degree of stability in selling projects is possible by taking advantage of the various co-operative schemes such as those operating for tar and benzole, under which long-term contracts are arranged whereby the gas boards receive an interim price per unit of raw material, plus a share of the ultimate profits resulting from the working up of the material by the buyer.

So far as tar products at least are concerned, it is encouraging to note that, notwithstanding the potentialites offered by the new methods, which will doubtless supersede carbonisation to a large degree as a process for the primary object of making town gas, chemicals obtained from coal by traditional methods will continue to occupy an important position as an integral part of the economy of gas manufacture for a long time to come.

CHEMICAL AND BY-PRODUCT SURVEY

Increasing thought is being given these days to those facets of the gas and coking industries which are related to the production of chemicals and by-products, but this trend has not been mirrored to any appreciable extent in the Press. Believing that the time has come for a re-appraisal of the history, present state and future prospects of chemicals and by-products, we are devoting the major part of this and the four following issues of the 'Gas Journal' to the publication of 19 exclusive articles dealing with every aspect of the subject.

INTRODUCTION BY W. K. HUTCHISON, *C.B.E., B.A., B.Sc.,*

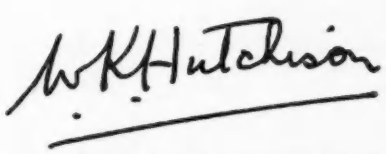
President, Institution of Chemical Engineers.

THE by-products of the gas and coking industries have always made an important contribution to the progress of the chemical industry. In the inorganic field ammonia recovered from gas liquor contributed to the successful development of the ammonia soda process which founded the fortunes of Brunner Mond at Northwich. The artificial dye stuff industry was founded on the anthracene recovered from coal tar. In this country at least the principal source of aromatic compounds, benzene, toluene, naphthalene and phenol, is still coal tar and crude benzole recovered from coal gas.

The efficient recovery and processing of these and any other by-products has engaged the attention of scientist and inventor since the earliest days of the industry, and much of the technology evolved has passed into the practice of chemical engineering—and it can always be recalled when viewing the spectacular progress of the oil industry that the first pipe still was built by Lennard for tar as long ago as 1884.

But the successes of the past are no grounds for complacency : The rapidly expanding chemical industry, particularly on the plastics side, is already looking to the oil industry for some of its supplies of aromatic products, either extracted from suitable oil or produced by cracking and chemical synthesis.

The publication of this series of articles by the 'GAS JOURNAL' is most timely and will serve a valuable purpose by bringing to the notice of all concerned recent achievements of chemical engineering in the field of by-product recovery and thus provide a stimulus for further advances in the recovery of valuable pure products and the rationalisation of their production.



DEPUTY CHAIRMAN, THE GAS COUNCIL

TWO CENTURIES OF BY-PRODUCTS

—an historical review

BY E. G. STEWART,

M.Inst.Gas E., F.Inst.F.

THE derivation of useful products from the heat treatment of coal is of considerable antiquity, antedating the formation of the gas industry by 150 years. In 1636 Peyton patented the production of coke for smokeless domestic fires and for the sweet drying of malt. The first part of the patent made no headway but the second was taken up, with great advantage, by Derby brewers. In 1709 Abraham Darby expounded the value of coke in iron manufacture, but the demand for such coke did not materialise till after 1750. From this date the coking industry steadily expanded, using the beehive oven for the next 150 years.

The extraction of tar was patented by Becker in 1665, and in 1681, in conjunction with Searle, he improved this to a method of making pitch and tar the equal of Swedish wood tar for preserving wood and ropes. In 1772 a similar patent was taken out by Van Haake. The market for coal tar came to the fore after 1775 on account of a shortage of wood tar arising from the American War of Independence. Champion proposed obtaining tar from beehive ovens in 1779 and Dixon of Cockfield was sending tar so derived to Sunderland in 1783.

In 1781 the Earl of Dundonald filed his famous patent for obtaining from coal, tar, pitch, essential oils, salts of ammonia, etc. He set up the British Tar Company which functioned successfully for nearly 30 years.

The carbonisation experiments which led to Murdoch's historic discovery of the value of gas lighting commenced as an investigation into suitable preservatives for ships' bottoms.

Winsor's grandiloquent estimates

It is not surprising, therefore, that Winsor was fully cognisant of the value of by-products from gas production. Indeed, his grandiloquent estimates of £570 interest per annum on each £50 share in his National Light and Heat Company were based on a gross over-estimation of the likely return from such products.

As is well known, in spite of these extravagances, his efforts resulted, in 1812, in the start of the gas industry. The terms of the first Act of Parliament to be followed in many of the early Gas Acts provided: 'For the making or producing of inflammable air, coke, oil, tar, pitch, asphaltum, ammoniacal liquor and essential oil from coal or other materials.'

Once operations had commenced, success in the sale of gas and coke (which was then of the nature of Coalite) was obtained in ever increasing measure.

Progress was less happy with the liquid residuals, and succeeding generations were to discover that while these could at times contribute handsomely to the profits of the undertakings, at other times they constituted problems of disposal and might even occasion loss.

Further, the early pioneers were soon to learn that, in addition to those residual products which they had envisaged, there were various refuses from the gas purification processes which would also have to be disposed of, frequently with difficulty.

Coal tar

There is evidence that certain manufacturers of painters' colours and varnishes were using, in 1809, naphtha and other tar products of the British Tar Company. But, when a few years later, the gas industry came into being no real market for tar, crude or refined, existed, nor were chemical manufacturers available to distil it.

Accum, of the Gas Light and Coke Company, made a number of trials and detailed the method for, and the products to be expected from, tar distillation. In 1818 this company set up a tar distillery at Poplar, London, which achieved initial success. Orders were obtained from several government service departments, exports were made to Hamburg and New York, and cargoes for home trade were sent as far as Aberdeen. Later the works did not pay its way and was sold, in 1833, to a private firm which contrived to operate it until 1840. Similarly, the Imperial Gas Light & Coke Company set up a tar and ammoniacal liquor works at Millwall in 1829.

The waterproofing process of Macintosh was invented in 1822. The naphtha required came from a private tar distillery at Leith, giving the first record of such an establishment.

At many of the new gasworks tar could be disposed of only (after a rough refining by boiling in an open tank with a little lime) as a waterproofing paint for gasworks, agricultural buildings, fishing vessels, wharves, and the like. In other places disposal was less easy and some works situated at the sea side or on fast flowing estuaries allowed their surplus tar to flow away.

As early as 1816, means were being tried in London and elsewhere to gasify tar, either alone or mixed with coke breeze. The systems all died out as the pitchy residues brought about difficult disposal and other problems.

Retort heating by tar

The practice of using tar as a fuel to heat the retorts commenced in 1827 and soon became normal practice. Clegg in 1841 says that 'coal tar as a substitute for wood tar fell into disuse after a few years and that the most economical use is to burn it beneath the retorts'.

In Gloucestershire in 1828-32, and in Nottingham in 1845, experiments were made with tar macadam on roads. The coming of the railways diverted interest from better roads and the experiments were forgotten. The principle was much longer lived as tar macadam footpaths were for

many years a feature of the Victorian scene and provided an outlet for some tar almost everywhere.

In 1838, Bethell patented his wood preservation process. At first using a mixture of tar and creosote, in 1845 he changed to all creosote. Almost simultaneously Warlick's patent for briquetting fine coals with pitch created a demand on the Continent for pitch.

The stage was set for profitable tar distillation. At home the new railway construction could absorb all the available creosote; abroad the market needed all the pitch produced.

Brilliant discoveries

In the next 30 years the development of industrial chemistry, accompanied by a series of brilliant discoveries, brought coal tar increasingly to the forefront as a source of valuable chemical products with a corresponding growing increase in its value.

In 1847 Mansfield separated the various constituents in tar and devised means for obtaining pure products from them. In 1856 Perkin discovered mauve and proceeded to develop other aniline dyes. In 1865 Lister propounded the virtues of carbolic acid as an antiseptic. The necessary phenol was abstracted by Lowe, Grace, and Calvert in 1872 from the carbolic oils of coal tar. The cresol fractions found uses as household and other disinfectants. In 1868 Graebe and Liebermann prepared alizarin from the anthracene in coal tar.

In the early days of aniline dyes benzole fetched 14s. per gal. and tar returned a correspondingly high price. In 1880 there were 130 tar works in operation. Most were owned by chemical manufacturers but a number of gas undertakings had their own plants. The Beckton plant of the Gas Light and Coke Company was started in 1879 and was soon followed by others belonging to gas undertakings in London, Glasgow, Newcastle, Plymouth, Exeter, etc. In 1883 the annual production of coal tar was 450,000 tons, or one sixth of today's figure.

With rapidly increasing production the fractions needed to supply the chemical industry soon reached saturation and tar prices had fallen sharply by 1886. About the same period the by-product coke oven was introduced. Competition in tar production was, however, small at first but increased rapidly after 1910. By good management and the building up of new and export markets the price of tar gradually rose and has given a reasonable return ever since.

CHEMICALS AND BY-PRODUCTS

About 1900 the coming of the motor-car directed attention to the state of the roads. On the Continent the earlier work on the tar dressing of roads had been revived, and in 1900 trials were started at Liverpool and London, and, in Kent. The practice came into general use from 1907. The first road tar specifications were issued by the Road Board in 1911. The new market thus opened resulted in a number of gas undertakings installing tar dehydration plants to improve the financial return from their tar.

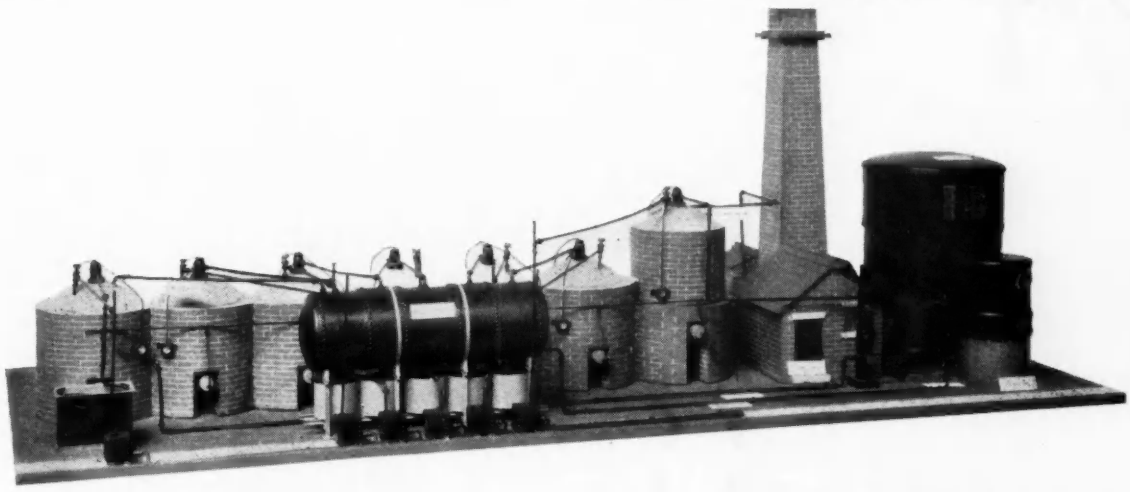
Following the 1914-1918 war much research was done on the desirable properties of road tars, and as an outcome improved specifications were devised and issued by the British Road Tar Association. These took into account the methods of application as well as essential properties of the refined tar. The Gas Light & Coke Company and the South Metropolitan Gas Company took the lead in supplying and applying specially blended tars in their own tank sprayers.

Highway authorities were quick to recognise the economy of these new tars and of their properly controlled application and turned to the large suppliers. The simple tar dehydration plants could not meet the new conditions and they went out of use, after 20 years, almost as rapidly as they had commenced. Today at some 40% of gasworks coal tar is blended to refined or road tar, and parcels are exported to America and New Zealand.

Co-operative price schemes

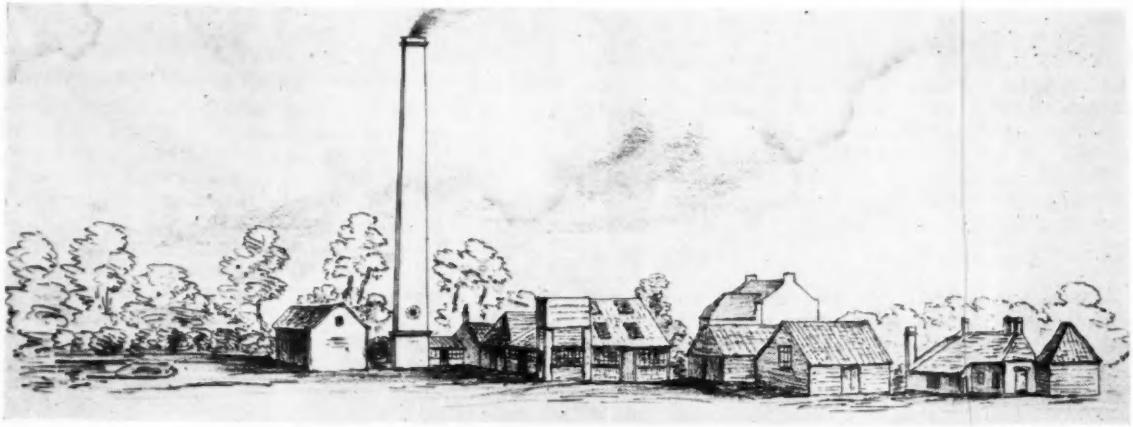
Up to 1920 tar had been sold to distillers on the basis of prices collected by and published in the 'GAS JOURNAL.' Changes in gas manufacturing methods and so of the properties of the resulting tars made these unreliable as criteria. Distillers and producers entered into co-operative schemes whereby prices were fixed on a standard basic figure plus a share of the distillers working-up profits. This sharing of gains has been most successful, and three-quarters of tar produced in the gas industry is still so disposed of today.

From 1935 various mergers have resulted in the closing down of many small distilleries and the concentration of distillation into fewer but larger plants, usually equipped with continuous stills. Today only five area boards distil



By courtesy of the Science Museum

The first continuous tar still by Lennard in 1893. It was made up from a number of pot stills.



By courtesy of the Science Museum

Sketch by Perkin of his first artificial dye factory in 1858.

their own tar, and two have works of the first magnitude. Nevertheless 25% of the production at gasworks is so treated.

In 1935 the I.C.I. plant for the production of home derived motor spirit was commenced The plant hydrogenated coal and creosote. A second plant, using only creosote, was built in 1941. These plants used about one-half of the creosote produced from gasworks tar. Recent petroleum developments have made this process no longer profitable, and the contract ceased, after 25 years, in 1959.

Coal tar fuels

As a consequence of fuel oil shortage in the 1914-18 war coal tar fuels were prepared for and used by the Royal Navy. After the war the idea was dropped, but commencing with the fuel shortage of 1940, tar fuel, prepared with new knowledge, was successfully re-introduced and has reached a sale of 120,000 tons per annum. Competition with fuel oil is, however, becoming increasingly severe.

The tar trade is severely competitive, and new outlets have to be sought continuously to replace those lost by competition or changes in demand. Naphthalene has found an increasing and as yet unsatisfied demand for plastics, whilst refined pitches are now much needed for electrodes, etc., in the aluminium and atomic energy fields.

Competition from petroleum and its products, from Continental producers, and the effects of high stocks of coal in this country and Europe, all tend to depress the present value of tar as a contributor to cheapen gas manufacture. The present production of tar is about 2.8 mill. tons per annum, of which 60% is contributed by the gas industry. It is treated in 100 works.

Ammonia

For the first two decades after the formation of the gas industry the production of ammoniacal liquor was confined, by reason of the then usual wet lime purification system, to the 10/12 gal. per ton of coal of virgin liquor. Many early gasworks were built alongside waterways and failing profitable means of disposal, such liquor was run to waste. As early as 1815 the Gas Light and Coke Company, under Winsor's son, were conducting experiments for the production of sulphate and other salts of ammonia. The principles of manufacture so established were expounded by Accum in 1819. He mentions that at that time some business was being done in the export to the Continent of the sulphate salt.

In 1829 the Imperial Gas Company were producing ammonia salts at their Millwall chemical works. In 1833 both the Westminster and Brick Lane works of the Gas Light & Coke Company were making sulphate of ammonia and salammoniac. Where gasworks were within reasonable distance of chemical, dyeing, or tanning establishments profitable sales could be effected. By 1840 one result of such sales had been to lower the cost of ammonium chloride by 80%.

After about 1830 difficulties in the disposal of the sludge from the wet lime process encouraged a change to dry lime, and later to metallic oxides. This change demanded the removal of that part of the ammonia previously removed by the wet lime. A number of processes were tried, often the gas was washed with acids, sometimes, after the manner of the direct recovery systems to be used 60 years later at coke ovens. The resulting solutions were evaporated to crystallised salt.

In many smaller works liquor not lost was evaporated, the gases being vented via a chimney; or it was used for coke quenching; or, as at Kirriemuir, Scotland, it was used on the land as a fertiliser.

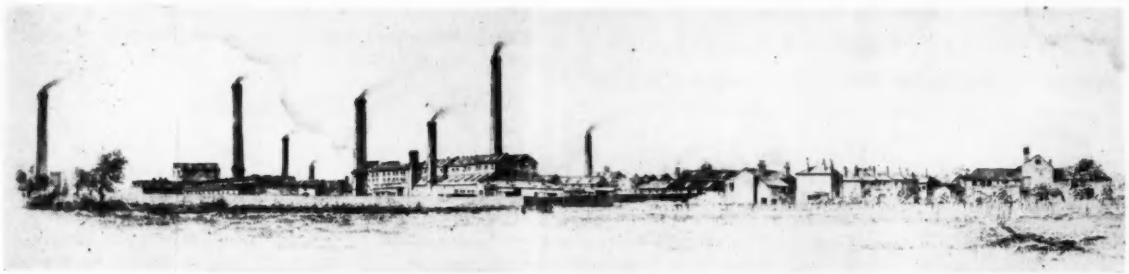
Tower scrubbers introduced

In 1846 Lowe introduced the tower scrubber and the practice grew of water washing for ammonia prior to the lime or oxide purifiers and not after them as previously. The virgin liquor was also merged into the washing system.

Nevertheless, by 1860 purification processes were still in a state of flux. Every important works had its own system leading to a variety of ammonia products in liquid and solid forms. With the setting up of the Gas Referees, and the introduction, a few years later, of statutory testing for quality and purity, standardisation of methods came about. Conversion on the works of the liquor to sulphate of ammonia became normal. The price of sulphate in 1880 was £20 per ton and as on any reasonable scale its production cost was under £5, it was a profitable operation. At least one ton of sulphate could be recovered from each 100 tons of coal carbonised.

This high price was encouraged by the rise in popularity of the Solvay ammonia-soda process and by new demands by the chemical industry for ammonia for refrigeration and other uses, as well as by the growing recognition of the value of artificial fertilisers.

Increased production resulted in some easing of the price, but it fell only to £15 per ton at which figure it remained



By courtesy of the Science Museum

This sketch, made in 1873, shows the remarkable expansion which had by then been carried out to Perkin's first dye factory. The original works can be seen to the right of the picture.

for the next 40 years. The by-product coke oven commenced in 1882. At first gasworks methods of ammonia recovery were used, but after 1905 direct recovery was general. By 1920 the sulphate output from the coking industry had reached parity with that from the gas industry but world demand could absorb all that was made.

Peak sulphate production

Generally, the gas industry processed to sulphate about 80% of its ammonia production and at its peak this production reached 130,000 tons per annum. In the '80's there were about 300 plants in operation, rising to 500 20 years later. The earlier plants used the batch boiling of the liquor in a boiler, the vapours going to an acid saturator, while the foul gases were destroyed in the boiler fire. Later plants used a plate still and frequently a secondary milk of lime still for the fixed ammonia. The foul gases were purified by oxide of iron purifiers or converted to pure sulphur in a Claus kiln.

This remunerative disposal of ammonia either to chemical works or through the undertaking's own plant continued, in all but the smallest and most isolated undertakings, till 1925. Indeed, in 1910 efforts were being made to bring in these small works by the use of a simple specialised plant. Most of the sulphate, about 82%, was exported. In the 1914-18 war this export was allowed to continue for fiscal reasons, and in addition sulphate was in demand for explosives, so once again the price rose to £25 per ton.

After the war various nations turned to the synthetic production of sulphate of ammonia. The British plant at Billingham commenced work in 1923. In seven years, as a consequence, the price of sulphate fell to £6 10s. per ton —less than the cost of manufacture by the old methods. The synthetic product gave rise, too, to new standards of colour, crystal size, acidity, etc., which could only be attained in the best modern plants with strict chemical control.

Marketing agency

Some of the loss in price was countered by the marketing agency, the Sulphate of Ammonia Federation. The number of sulphate plants, however, rapidly diminished as the once highly valued product lost attraction. Today the gas industry directly produces only 85,000 tons per annum, mainly from the large works of the North Thames and South Eastern Boards. The corresponding output of synthetic salt is 900,000 tons per annum.

Where it is essential to dispose of liquor to chemical works, etc., some reduction of loss can be made by concentration to ten times the ammonia strength, and many such plants are now in use. Even in the coking industry, where direct recovery is usually installed, 20% of liquor made is now concentrated.

In the present century ever-increasing attention has had to be given to effluent disposal. As one means of improving effluents from concentration and sulphate plants, a number of works have, since 1940, adopted the oil washing of liquor for the removal of phenols. In spite of the phenolic content being only 0.2 to 0.4%, the demand for phenols is such that this process considerably improves the economics of liquor treatment.

Once more the old ways of 'losing' liquor —of using it for quenching, and even of discharge into sewers—have had, with suitable pre-treatments, to come to the fore. The use of raw liquor as a fertiliser, first tried 120 years ago, is becoming more important, and some 10% of the total production is now applied under controlled conditions to the land.

Purification residues

Each of the means that has been adopted by the gas industry for the removal of sulphuretted hydrogen and other impurities from gas has resulted in the production of solid or liquid residues.

In the pioneer days the wet lime process resulted in 25 gal. of sludge for each ton of coal carbonised. On exposure to air the sludge gave off H_2S and produced an intolerable stench. It was usually discharged into a waterway. So long as works were small, say less than 20 mill. cu.ft. per annum, the flow was small in relation to the receiving flow and the result was tolerable. As works grew larger nuisance arose, and after 1830 a change was made to dry lime, and after 1850 to oxide of iron. Even so, at least two large London works were able to retain the wet lime process till after 1860 by evaporating the sludge to dryness and using the residue for lid luting, etc.

Dry lime as a fertiliser

The spent dry lime, although still odorous, was more amenable. It was found to be a good fertiliser, and in works within cartage reach of rural areas was easily disposed of at a slight profit. Dry lime was a usual purifying material from 1830-1860 and again from 1868-1910. The sulphur clauses necessitated its use in the second period. In 1901, of 998 gasworks 546 used lime alone, 81 oxide of iron alone, and 371 lime and oxide in combination. In metropolitan areas agricultural disposal was difficult, and the spent material was dumped on statutory land in massive heaps, or else used to make up levels on the works for which it formed a firm, non-corrosive and easily opened sub-soil.

Spent oxide of iron can contain 50% of sulphur, and from about 1860 was developed as a source of sulphur for sulphuric acid manufacture in this country and abroad.

CHEMICALS AND BY-PRODUCTS

The burnt residue either became the acid manufacturers' disposal problem or was reconditioned with soda ash, ferrous sulphate, and organic material for re-use. Selected oxides have proved a source of cyanides, and sulphur extraction by solvents has been practiced.

New pattern emerging

Until recently the return for spent oxide has contributed appreciably to reducing the cost of purification. With the discovery of sulphur laden natural gas at Lacq in France and elsewhere it would seem that a new sulphur providing pattern is emerging and spent oxide will soon cease to be a form of revenue. This loss of revenue from sulphur will also apply to new systems of liquid purification introduced in recent years in which pure sulphur is a final product.

Such systems also produce a liquid effluent. Although liquid effluents are outside the scope of this article they are in a sense by-products of gas manufacture. The gas industry has always had to dispose of effluents with varying degrees of contained solid matter and toxicity. The first of a long series of statutory limitation or control of such disposal occurs in the Gas Works Clauses Act of 1847. From this time but particularly in the past 40 years, the industry, aided by much research, has delivered effluents with lessened toxicity and other undesirable characteristics, but at ever increasing treatment costs.

Retort carbon

Retort carbon is produced in retorts as a result of the degradation of hydrocarbons in contact with the heated interior surface in the form of a deposit up to 1½-in. thick and in amount varying between ½ lb. to 2 lb. per ton of coal.

From 1870-1920 the carbon had a steady market for the production of arc lamp carbons and electric motor brushes. In recent years it is mostly removed by controlled combustion and production is disappearing with the horizontal retort.

The products considered so far have been those inevitably resulting from the process of gas manufacture and purification. A few products have, from time to time, been produced by deliberate extraction from gas, etc., because their value was in excess of the price normally received for the main product.

Cyanogen

The presence of cyanogen compounds in gas liquor was recognised in 1832 by Lowe, Chief Engineer of the Gas Light & Coke Company. He devised a method of removal using ferrous sulphate as a mean of producing Prussian blue. After 1860, cyanogen compounds were needed in the preparation of aniline black and the usual source was spent oxide of iron.

In 1890 the MacArthur Forrest process of gold extraction created a substantial demand for sodium cyanide. In 1892 Foulis of Glasgow devised a means of extraction from coal gas, and in a few years the removal of cyanide from coal gas was entered upon by a number of the larger gas undertakings. At least five processes were used: Wilton, Davis-Neill, Chance & Hunt, Rowland-Bueb, and of course Foulis.

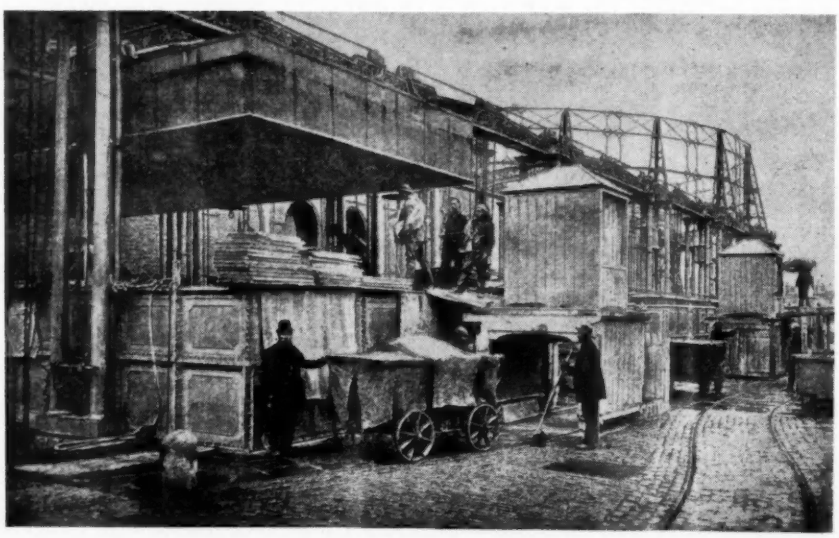
Recovery was equivalent to 2-4 lb. of Prussian blue per ton of coal. Profitable extraction continued until 1920 when the Forrest process was exchanged for another and the market vanished leaving only a small demand for the production of blues. It is 40 years since extraction of cyanide ceased, so it may be worth recalling that when it was practiced most of the difficulties now associated with oxide of iron purification, which have been the subject of considerable research, did not exist.

Benzole

Benzole was originally discovered in 1825 by Michael Faraday to be a constituent of the condensate from compressed oil gas produced by the Portable Gas Company. In 1845 Hoffman, and in 1847 Mansfield, discovered it in coal tar, and the latter produced it in a purified state.

It was always an important hydrocarbon constituent of coal gas, and its retention was essential to maintain the illuminating power. From 1869-1875, however, when benzole was in great demand for the new aniline dye industry some benzole was extracted at Manchester gasworks by gas washing with creosote oil.

The washing of gas for benzole recovery to the fullest extent has always been a feature of by-product coke oven



Spent lime is seen being removed from pumpers at Fulham in 1879. The wooden 'pavilions' with canvas curtains and the sheeted wagons were designed to avoid nuisance from smell.

practice. The amount recovered started to become substantial by 1906 and has increased ever since, so that for the past 50 years, at least, two-thirds of gas-derived benzole has so originated.

In 1903 a new market for benzole as a home-produced motor spirit was initiated and had become established by 1907; the spirit was much improved after 1913 by the addition of tri-cresol as a gum inhibitor. The business has since been maintained through what is now the National Benzole Company.

The demand for toluene in the 1914-8 war led to the abandonment, for the duration, of the statutory illuminating power requirements. All gas undertakings were called upon to wash their gas. Commencing with tar washing by the 'C' process and recovery after tar distillation, the installation of creosote oil washers and stripping plant went ahead rapidly. By 1918 all except the smallest works were extracting and the gas industry's output exceeded 7 mill. gal. annually.

Effect of Gas Regulation Act

Except at a few large works this recovery ceased at the end of the war and was not resumed till 1928 by which time the Gas Regulation Act and sale of gas on a thermal criterion had come into full force. The new recovery was inspired by duties on imported petrols in 1928, increased in 1931. At that time some 90 gas undertakings were producing 11 mill. gal. annually—20% of the national production. In 1934 the British Hydrocarbon Fuel Oils Production Act offered further financial advantages plus a guarantee of nine years' protection. The industry extended benzole recovery and soon 95% of gasworks carbonising over 5,000 tons of coal per annum were removing benzole. Annual production rose to 24 mill. gal. and during the succeeding war to nearly 40 mill. gal.

After 1934 new types of extraction plants, using either active carbon or gas oil at high flow rates distilled under vacuum, came into use. A subsidiary advantage of these processes was the lowering of the organic sulphur compounds in gas to 10 grains per 100 cu.ft. Economic changes since the war have led to some falling off in the gas industry's production of benzole which is now around 25 mill. gal. per annum. The virtues of sulphur reduction and of a consumer who can be 'cut off' at peak load times are still strong incentives to continued recovery even where the lost therms have to be replaced by l.p. gases.

Germanium

In the past seven years an unexpected but remunerative by-product has made a small contribution to gasworks

costs. It was found that the flue dusts in particular designs of continuous vertical retorts carbonising Durham coal contained up to 1.5% of germanium dioxide. This material is in demand for the manufacture of the transistors so much needed in modern electronic equipment. Small as is the concentration, its recovery is worthwhile and the appropriate flue dusts command £15-£21 per ton.

Table 1. shows the gross and net returns for by-products other than coke for the past five years. The figures show a general rise in the prices received for the tar, etc.; a fall in the return for benzole; and the change from a profit in the case of ammonia, spent oxide, etc., to a loss due to the increasing costs of ammonia disposal. The effect of the falling quantity of coal carbonised is particularly noticeable in the last year, especially as there was also a slight fall in the prices realised for tar as a consequence of oil and other competition.

TABLE 1.

Year	Coal carbonised millions tons	Gross receipts £'s millions	Net profit £'s millions			Total profits £'s millions
			Tar and tar products	Benzole	Ammonia, oxide, etc.	
1954/5	27·3	20·4	11·27	0·71	0·16	12·14
1955/6	27·7	21·4	11·93	0·45	0·05	12·43
1956/7	27·6	23·4	13·60	0·40	0·01	14·01
1957/8	25·9	24·3	14·59	0·14	0·03 (loss)	14·70
1958/9	24·1	21·5	12·78	0·05	0·02 (loss)	12·81

Turning dependability to good advantage

Such is the story of the by-products of the gas industry and their vicissitudes. Today the profits are mainly from tar and its products. Fifty years ago they were divided almost equally between tar and ammonia. With the development of new gas-making processes using non-coking coal and oil as raw materials a new range of products is arising. Already some of the new tars are being used in the manufacture of plastics. One thing is clear: However the industry may develop, its by-products are essential to the chemical industry, and its enterprise will surely see that this dependability is turned to good advantage.

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GAS JOURNAL August 31, 1960

Recovery of benzole from coal gas —a general review of methods

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THE economic aspect of benzole recovery is discussed in another article in the present survey. Where economics are favourable, benzole may be recovered from coal gas produced in all normal types of carbonising plant.

The efficient processing of the gas prior to benzole recovery is of the highest importance, especially cooling and the removal of ammonia. If cooling is inadequate the recovery of benzole by the usual methods will be low, and if ammonia has not been reduced to a low figure, corrosion of benzole recovery plant is almost certain to follow. Also, since benzole plant may be liable to sludge trouble, this nuisance is increased by passing forward unnecessary amounts of tar fog with the gas. At gasworks it is usual to remove hydrogen sulphide from the gas before benzole recovery, but at coke ovens this is rare.

Coke-oven gas has a high calorific value, and benzole may often be extracted from such gas without affecting its saleable value for town gas purposes. Gas from steamed vertical retorts is of lower calorific value, and the economics of benzole recovery in this instance depends largely on the market for coke. If this is good, as much coal as possible will be carbonised, and benzole will be recovered. If the coke market is poor, the tendency will be to carbonise as little coal as possible and to make the greatest possible amount of suitable gas from it. This entails leaving some or all of the benzole in the gas in order to maintain the statutory level of calorific value in the gas supplied to the public.

Three methods

The recovery of benzole from coal gas is usually effected by one of three methods: Absorption, adsorption, and compression/refrigeration, of which the first is by far the most generally employed.

Recovery of benzole by absorption. In this method, the gas is scrubbed in countercurrent by circulating oil, which is then steamed to recover the benzole, cooled and repassed to the gas scrubber. The features governing the efficiency of benzole absorption are the temperature of gas and oil, the quality and quantity of the oil, and the intimacy of contact between the oil and the gas. The physical significance of cooling depends on simple effects of partial pressure. So long as the partial pressure of the benzole in the gas exceeds the partial pressure of the benzole in the oil, the oil will tend to absorb benzole, and the reason for countercurrent treatment of the gas, whereby gas of low benzole content is scrubbed with oil of low benzole content, becomes apparent. The absorptive capacity of wash oils for benzole falls very rapidly with increasing temperature. Thus, the percentage by weight of benzene in a wash oil which will exert a partial pressure of 6.5 mm. Hg absolute—this being the average partial pressure of benzene in coal gas—varies as shown in Table 1.

The types of absorbers most generally employed are tower scrubbers, bay washers and plate scrubbers.

In tower scrubbers, the oil is usually distributed near to the top, and flows over a board filling. The oil may be made to enter below a few of the top boards, which then act as spray arresters. An internal tower capacity of about 1.6 cu.ft. per 1,000 cu.ft. of gas passing per day is normal, and each tower, when clean, usually exerts a back-pressure of about 1 to 2 in. w.g. Board packing has almost entirely replaced earlier forms of packing such as rings and spirals, but it now seems very probable that unpacked scrubbers, which are widely used in U.S.A., will, in turn, replace board-packed towers. In these the oil is distributed as a fine spray by pressure pumping, and this may be repeated in each of three tower sections. Although it has been reported that the unpacked scrubber requires the use of increased amounts of oil, it would seem that this can be overcome by recirculating the oil in each section at a higher pumping rate, overflow to the next section being at the rate of the actual input of fresh oil to the pump supplying the top section of the first tower entered by the oil. Such a general system would seem to offer several advantages:

1. Increase of contact efficiency for lesser input of oil.
2. Reduction of back-pressure.
3. Avoidance of sludging troubles, and the difficult operation of cleaning.

Plate scrubbers are rather more compact than tower scrubbers, and contact is effected on plates similar to those employed in distillation columns. Bubble caps may be employed, and are rather more positive than simple perforated plates. Plate scrubbers are often considered to be more liable to fouling than tower scrubbers, but they are much more easily cleaned by dismantling.

Bay washers consist of sets of rectangular, mild-steel or cast-iron vessels divided into a number of divisions, or bays. The wash oil enters at the end opposite to the gas inlet, and travels along from bay to bay over a series of weirs. The oil is pumped from the base of each compartment back to the head of the same compartment, by means of a multiple centrifugal pump, and the lay-out is thus very suitable for high-rate recirculation of oil in each bay. The oil is spread in the bays by means of ceramic packing or special brush fibre, over which it may be distributed evenly by perforated pipes.

It would seem that this type of plant might easily be adapted to an unpacked form, as proposed for tower scrubbers.

TABLE 1.

Temperature °C.	Creosote	Gas Oil
0	10·9	8·15
10	6·3	4·8
20	3·8	3·0
30	2·4	1·9
40	1·55	1·3

Continuance of efficiency of a benzole scrubber depends on proper maintenance, the main features of which are gas rate, oil rate, temperature, back-pressure and general technical control. Gas and oil rates are flexible features, but in general it is necessary to apply not less than 100 gal. of oil for each 3 gal. of benzole to be absorbed. There are many plants, especially at gasworks, where higher-than-normal proportions of oil are circulated in order to reduce the residual organic sulphur in the scrubbed gas—especially carbon disulphide. It follows that a high recovery of benzole is also possible.

The effects of temperature have already been noted, and back-pressure usually means fouling of the scrubber by sludge, when the necessary steps must be taken to clean, either by steaming, solvents, or dismantling.

Technical control

General technical control includes such items as the quality of oil and the slip of benzole past the scrubbers, these being determined by laboratory tests or the introduction of special instruments. At the present time, the rapid development of instruments for continuous or semi-continuous recording of the benzole in gas is taking place by application of gas-liquid chromatography and photometric methods. The recovery of benzole on modern plants working under good average conditions is about 90% that originally present in the gas.

Control by instrumentation of oil-circulation rates by means of level controllers activated by the level of oil in the sumps at the base of each scrubber, now permits of equal oil supply to each of a number of scrubbers working in series, so that manual control is unnecessary except for adjustment of the actual feed rate of oil to the plant.

CHEMICALS AND BY-PRODUCTS

Steam stripping at atmospheric pressure. This is the most usual method of benzole recovery from benzolised oil used in Britain. The benzolised oil is heated and steam is passed through to act as a carrier for the benzole. When cooled, the steam condenses and is no longer available as a carrier. The benzole, therefore, condenses simultaneously. (Fig. 1).

Apart from the steam required to function as carrier, over 90% of the heat required is to heat the benzolised oil and less than 10% for evaporation of the benzole. A considerable proportion of this heat requirement is met by leading the benzolised oil to the still first through a vapour-to-oil heat exchanger whereby its temperature may be raised to some 70°C., and then through an oil-to-oil heat exchanger where its temperature will be raised by a further 25 to 30°C. It is, however, preferable that the temperature of the oil should be raised to about 120 to 130°C. before injecting steam, and this is brought about by means of an indirect steam preheater, the temperature of the steam being maintained by a steam trap at its outlet.

The preheated benzolised oil together with any vapours that may have been released, are taken to the head, or near to the head of a vertical plate stripping still or column which it descends, intimate contact with the ascending steam, usually injected at the base at about 20 p.s.i.g., being effected by means of the plates or trays which are generally of bubble cap or other common form. When it reaches the base of the still, the oil should be free from benzole, and on the efficiency of this stripping, which should be

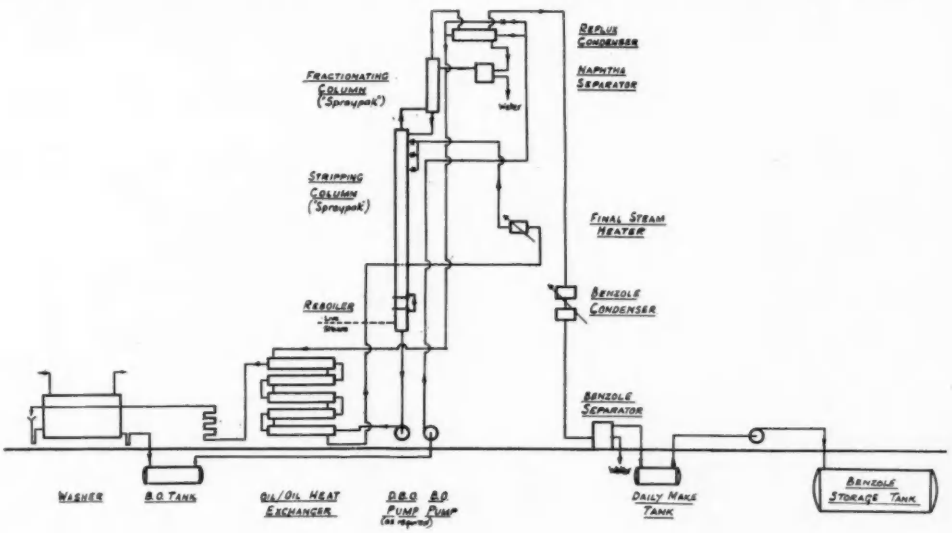

FIG. 1.

Debenzolisation of the oil after benzole absorption is effected by means of steam, and since the cost of steam may be high, the conservation of the heat available in the benzole/steam vapours becomes a matter of the highest importance. Heat conservation is by lagging, and by making use of heat-exchange devices whenever practicable.

There are three general methods available for the debenzolising of benzolised oil, steam distillation at atmospheric pressure, steam distillation under reduced pressure and the use of pipe stills.

checked by frequent laboratory tests, depends the efficiency with which the debenzolised oil will function when it is returned to the scrubbers. Leaving the still, the oil passes through an oil-to-oil heat exchanger, wherein it functions as heat donor, and then through oil coolers back to debenzolised oil storage.

The benzole/steam vapours leaving the top of the still generally contain a considerable proportion—up to 20%—of wash oil, and the usual practice is to lead such vapours to the base of a ring-packed column surmounted by a

CHEMICALS AND BY-PRODUCTS

dephlegmator. By suitable control of the vapour offtake temperature, *i.e*, at about 83°C., it is possible to obtain a distillate of once-run crude benzole distilling on test some 90 to 95% at 160°C. The condensed excess steam, wash oil and naphthalene is run from the base of the still to trays where the water is separated and, after cooling, the oil may be drained from the solidified naphthalene. This oil may then be pumped to the debenzolised oil storage. The dephlegmator on such crude benzole rectification columns is usually built in two sections. The first acts as a vapour-to-oil heat exchanger, being cooled by incoming benzolised oil, and the second is cooled by water, the supply of which is controlled by the final vapour offtake temperature.

Steam stripping at reduced pressure. In about 1935, a vacuum debenzolising process was developed by the Gas Light and Coke Company in co-operation with W. C. Holmes & Co. Ltd., and considerable numbers of these plants now function with complete satisfaction. Such vacuum benzole recovery was designed to reduce the consumption of steam in cases where higher-than-normal oil circulation is employed, and in this it has proved particularly successful. A typical vacuum still is fed with benzolised oil preheated in the usual manner to about 90°C., and operates at a vapour offtake temperature of about 82°C. and 10 in. Hg absolute pressure. The steam for stripping is generally about 15 lb. per 100 gal. of oil. The input and output of oil are conveniently controlled automatically by float valves placed in the base of the still. The first of these prevents the benzolised oil pump from overfilling the still, and the second maintains a constant level for feeding the oil extraction pump. (Fig. 2).

hot debenzolised oil and then passes to a pipe still. The steam/oil mixture that is vaporised in the still is freed from wash oil in a column up which a small quantity of steam is passed. After condensing and separating the water, this crude benzole is passed through a second pipe system, and the issuing vapours are fractionated to give benzole, toluole and solvent fractions.

In the U.C.B. Wilton pipe still only the debenzolised oil passes through the still. Oil-to-oil preheated benzolised oil enters the lower half of a distillation column where it is mixed with hot debenzolised oil, whereby the volatile constituents are released. This mixed debenzolised oil runs from the base of the column at about 150°C. and is substantially free from benzole. It is pumped to the pipe still and re-emerges at about 185-190°C. It then enters the upper half of the column where it is steam stripped, and then descends to the lower section of the column where it mixes with and debenzolises the incoming preheated benzolised oil. The benzole vapours pass to a fractionating column where they are freed from heavy end products such as naphthalene.

Debenzolised oil is circulated through the pipe still at two to three times the rate of input of benzolised oil being withdrawn from the steaming chamber, and pumped back to the scrubbers round a ring main which feeds reboilers on a series of fractionating columns in which fronts, benzene, toluene and xylene fractions are separated. This method effects a very great saving of heat. Control of debenzolising plant is comparatively simple with modern instrumentation. In the steam operated plant, the oil level in the still base can be made to control the oil input, still pressure to control the steam input, and the vapour offtake temperature to control the input of dephlegmating water. The temperature of oil entering the still is maintained by causing it to control the supply of steam to the preheater. Control of vacuum plant is very similar, and it is equally

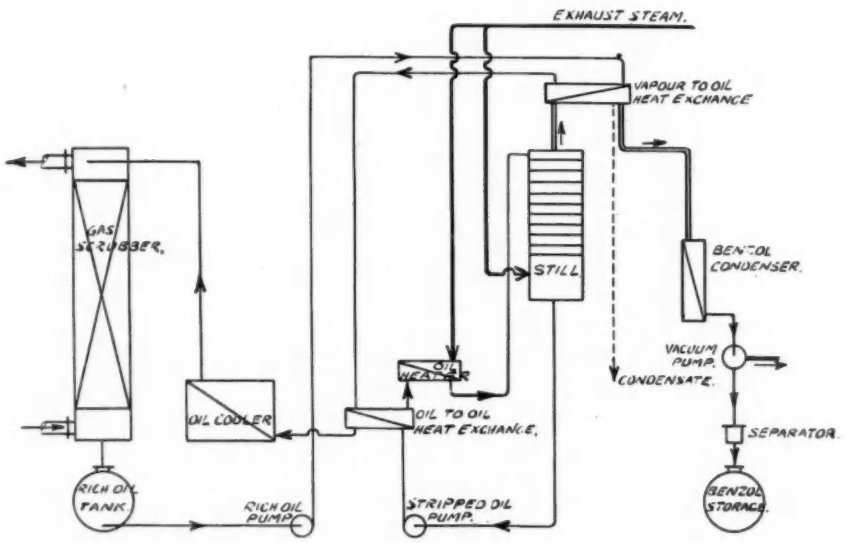

FIG. 2.

The vapours leaving the still are again cooled in a two-stage system. The condensate from the vapour-to-oil heat exchanger is normally drawn off by a barometric leg. All the remaining condensates go through the vacuum pump.

Pipe stills. These are used extensively on the Continent. In the Koppers system, the benzolised oil is preheated by

evident that levels, temperatures and differential pressures may be adapted to control of pipe-still working.

General control of benzole recovery plant. Control is simple, provided an adequate routine of supervision is established from the start of working of the plant. As the working life of the plant increases, certain rather general

troubles are almost certain to make their appearance, such as sludge manifestations, emulsification and corrosion.

The sludge nuisance can take two forms. Owing to their solubility in coal tar oils, sludges tend to cause such wash oils to thicken and become less easily applicable to benzole absorption, but comparative insolubility in petroleum wash oils permits deposition of the sludges at various points of the plant. Reference has already been made to the efficacy of the unpacked scrubber in obviating sludge troubles, but it should be possible to enter and clean all other plant units with the minimum of difficulty. It is interesting to report that sludge trouble is practically unknown on Holmes vacuum debenzolising plants, although almost all, if not all, are using petroleum wash oil. The obvious inference is that the heating of benzolised oil to about 100-110°C. or higher is a potent influence in the formation of sludge.

Wash-oil regeneration

The most effective way of reducing sludging trouble is by wash-oil regeneration. Some success has attended direct shock cooling of petroleum wash oils with water, but methods of distillation are generally employed. It is not necessary to distill the whole of the oil, but only such a proportion of the circulating oil, usually about ½ to 1%, that the removal of the total sludge from this proportion followed by its re-addition to the oil bulk, is equivalent to the formation rate of sludge in the total circulating oil. Two processes have been employed successfully to this end. In the Clayton continuous regeneration plant, the hot debenzolised oil is heated to about 220°C. by a gas heater, and is then subjected to direct steam distillation at this elevated temperature. In the second method, a portion of the hot oil, either benzolised or debenzolised, is run to a small still where it is heated indirectly by high-pressure steam, and at the same time high-pressure steam is injected into the oil. Superheated steam distillation ensues, and both steam and distilled oil are passed into the base of the stripping still, where the distilled oil rejoins the oil bulk and the steam serves to strip the benzole out of the descending benzolised oil.

Emulsification is a less serious trouble, and is almost invariably caused by water in the oil. If due to extraction of water from the gas, the temperature of the oil should be kept about 1 to 2°C. above that of the gas, when the extraction of water will be obviated. If it occurs in the stripping still, the conditions of operation must be altered, such as by raising of temperature so that the water does not make its appearance.

Although many theories have been advanced for the causes of corrosion on benzole plants, it seems reasonably certain that it is mainly due to thiocyanates, and these are mainly the result of the reaction between ammonia and carbon disulphide. It is essential, therefore, that ammonia in the gas should be reduced to the lowest figure reasonably possible before entering the benzole scrubbers. Some success in combating corrosion has attended the use of tubes of special steel alloys in the benzole preheater, which is a common position for attack because of the temperatures involved and the presence of impurities which disappear during the subsequent stripping.

The recovery of benzole by adsorption is, in some sense, not dissimilar to its recovery by absorption. Many adsorbents have been investigated, but only active carbon appears to have merited general application. Although moving beds of adsorbent have had some success in the petroleum industry, only fixed beds of active carbon have so far been used for benzole adsorption, and herein lies the chief operational difference between the two methods.

CHEMICALS AND BY-PRODUCTS

Instead of circulating a bulk of oil, one part of which is engaged in scrubbing the gas while the benzole is being steamed out of the remainder, the adsorbent is housed permanently in at least two containers. While the gas is passing through one of these, the other is being steamed for recovery of the benzole.

When it is necessary to handle very large volumes of gas, the number of adsorbers will have to be increased, and a suitable cycle of operation determined. As with wash oil, the quality of the adsorbent gradually deteriorates owing, in this case, to pore blockage by gums and other impurities, but unlike wash oil, it is not reasonably possible to reactivate the adsorbent *in situ*, and the recovery of benzole is only maintained by shortening the operational cycle or by reducing the volume of gas passed through an adsorber before it is steamed out.

There is a tendency for oxygen present in the gas to oxidise hydrogen sulphide to sulphur in the pores of the adsorbent, and there are processes of sulphur production based on this reaction. In a process of benzole recovery, therefore, it is necessary that the hydrogen sulphide shall have been removed from the gas before it enters the adsorber, and this has limited adsorption processes to the treatment of purified gas. This process is, therefore, almost entirely confined to gasworks, where gas purification is normal procedure, and cheapness with convenience has led to the installation of a considerable number of adsorbent plants at small gasworks. The total number of such plants is well over 50, but few of these are still in operation. A considerable number have been installed on the Continent, some for the removal of naphthalene rather than benzole from the gas.

Adsorption theories

The theory of adsorption is much more complicated and much less understood, than the theory of absorption. Two main theories have been advanced: In the first, the vapour simply condenses as liquid in the fine pores of the adsorbent; in the second, advanced by Langmuir, forces of a chemical nature are assumed to be involved, and there is nowadays a tendency to prefer this view.

One of the chief advantages of active carbon over many inorganic adsorbents, such as silica gel, are that it adsorbs benzole in preference to water. The preparation of suitable grades of active carbon is not a simple process. Whatever carbonaceous types of raw material are selected, it is necessary to activate them, *i.e.* to open out its structure to the requisite degree of porosity. Very generally, this is nowadays effected by means of steam at about 900°C. The raw material is first ground into a paste with a suitable binder, worked into granules of suitable size and form by extrusion and cutting, and followed by a preliminary drying.

The desirable properties in an adsorbent are bulk density, hardness, pore size, adsorptive capacity, abrasion, and low resistance to gas passage.

When the adsorptive capacity has fallen during use to from 5 to 10% of the original, the adsorbent may be reactivated by the maker by retreatment with superheated steam.

The adsorption plant for benzole recovery and its operation. Perhaps the most important feature of operation is that the direction of gas flow and steam shall be in reverse. The gas tends to leave gums in the pores of the adsorbent,

CHEMICALS AND BY-PRODUCTS

more especially near the point of first contact, and by steaming out the benzole in the reverse direction the tendency is to drive such gums out of, rather than further into, the active carbon mass.

In most of the smaller plants the gas passes horizontally through an annular ring of adsorbent, and steaming is effected from inside this ring of material.

Most of the published experimental work has been carried out on the large plant at Beckton, which produces 20,000 gal. benzole daily, and the smaller plant at Bromley, both belonging to the North Thames Gas Board. The purified gas passes upwards through beds of active carbon about 4 ft. in depth, and steaming is in the reverse direction. Tubes embedded in the adsorbent bulk enable heating and cooling during and after steaming. (Fig. 3.)

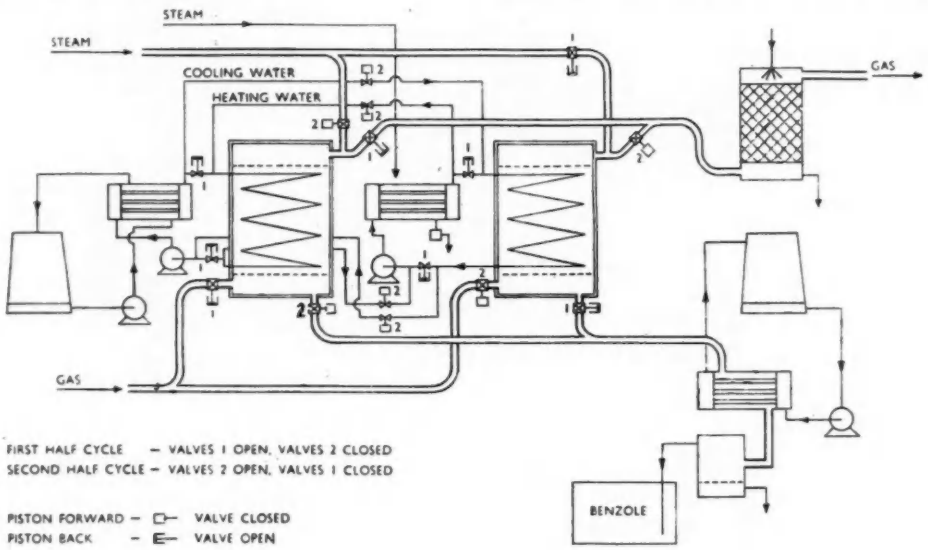

FIG. 3.

It has been found advisable to serve these tubes with the same oxygen-free water, either hot or cold according to the operation in progress. It has also been found necessary to cool the mass as rapidly as possible after steaming, and to turn on the gas again as soon as possible. This helps the rapid cooling, and quickly reduces the residual moisture to the normal level. The point of benzole break-through is conveniently recognised as the flame from a small bleed-off of debenzolised gas suddenly becomes luminous.

The efficiency of the process is at least the equal of the absorption procedure, and in fact the adsorbent loses efficiency to only some 50% of the loss of efficiency of wash oil per 1°C. rise in the stripping temperature, when this is in the normal region of, say, 20°C. In general there is no great difference between the costs of the two processes, as shown in Table 2.

The recovery of benzole by compression and refrigeration. Pressures of several atmospheres are employed in these processes. Up till now such methods have not been used in Britain, but would undoubtedly be considered should high-pressure gas distribution be introduced. This is because the mere recovery of benzole does not merit the cost of compression, and only in cases like that of Ruhrgas, where gas is accepted at a pressure of 7 to 9 atmospheres, or when the gas is to be compressed for separation into its constituents, are such methods economically attractive.

Much work has to be performed on the gas before either compression or refrigeration will cause benzene, the chief constituent of benzole, to condense. At 20°C. the partial pressure of benzene at saturation point in gas is about 75 mm.Hg, but the partial pressure of benzene in coal gas as made is usually only about 7 mm.Hg. The gas must therefore be compressed to about 10½ atmospheres before the partial pressure of benzene will reach the higher figure, and the benzene begins to condense. When a cooling process of extraction is employed, the gas must be cooled to about −20°C., at which temperature the partial pressure of benzene at saturation point is about 7 mm.Hg, before the benzene begins to condense. In any case, a much higher pressure or a lower temperature will be applied before substantial proportions of the benzene would be condensed, and it is usual to combine the effect of compression with either refrigeration or scrubbing. The second alternative belongs, perhaps, to the recovery by absorption, but has some interesting features.

Different types of wash oil may be used, such as coal tar naphtha, and the plant may be much reduced in size, although it must be much more robust. The yield of benzole recovered is greatly improved, and may even reach nearly 100%. It it not usual to employ very low temperatures in these scrubbing methods, but if the gas is slightly over-compressed and, after water-cooling,

TABLE 2.

	Wash oil	Active carbon
Residual benzole, grains 100 cu. ft. ..	80	60
Steam, tons/ton of benzole	4·5	4·5
Cooling water, gal./ton of benzole ..	15–20,000	10,000
Power, kWh/ton of benzole	80–120	80,120
Wash oil, lb./ton of benzole	225–350	—
Active carbon, lb./ton of benzole ..	—	18–25

brought back to normal temperatures, it is then allowed to expand slightly, and moderate sub-normal temperatures between say 0 and 5°C. may be reached with a greatly improved scrubbing efficiency. It is not advisable to reduce the gas temperature too much because of the risk of icing. In fact, this nuisance has to be side-tracked in almost all cooling procedures of benzole recovery, and solidification of naphthalene must also be avoided.

True compression/refrigeration operation always faces one unusual difficulty. Despite attempts to overcome this by co-condensation of the total benzole products or by addition of extra toluene or xylene, the last quota of benzene is invariably recovered in solid form. This difficulty is usually surmounted by condensing such final benzene in one of two vessels, each of which is designed as a form of heat exchanger and each sufficiently large to hold enough of the condensed solid before it unduly increases the back pressure. At this point the gas flow is reversed in respect of the two vessels, and first passes through the warming section of the heat exchange system of the vessel containing the solid benzene, whereby it causes liquefaction of the solid benzene and is itself cooled prior to entering the second vessel to deposit its benzene.

In compression/refrigeration plant it is usual to effect the cooling by means of a small subsidiary ammonia refrigeration plant, this being more economical than over-compressing followed by water cooling and final partial expansion.

CHEMICALS AND BY-PRODUCTS

It is interesting to note that if a proportion of the gas make is utilised for oven or retort heating, this proportion will not be compressed. The economic balance between the size and side-by-side operation of the normal- and super-normal pressure plants is decidedly complicated, being very sensitive to the demands for towns gas.

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Goodyear 'cures' rubber by an accident

By M. SCHOFIELD

THE centenary of Charles Goodyear's death last month marks an anniversary important not only for rubber technology, but also the development of the gas industry.

Goodyear is remembered for his vulcanising or curing of raw rubber, an accidental discovery made after years of trying every conceivable reagent and solvent for his 'gum elastic' in order to adapt it for commercial use.

He was a man with a fanatical faith in rubber for the making of boots and shoes, rubberised textiles and other articles.

Failure was the keynote throughout the career of this American. He went through the fortunes of his backers and friends, he pawned his wife's jewellery to pay his fare to Britain to exhibit his rubber articles, and he died a bankrupt leaving $200,000 in debts.

It was when he caught sight of a rubber lifebuoy in a window that Goodyear started experiments with rubber. The valve on it was a crude one, so Goodyear made an improved one and showed it to a manager of the firm concerned. The latter told him that he should apply his ingenuity to the curing of raw rubber.

So many years of hit-or-miss research began, with Goodyear kneading 'gum elastic' with chemicals ranging from magnesia to nitric acid solutions of metals. A druggist gave him chemicals and rubber to try further variations, while other backers enabled him to rent an abandoned factory on Staten Island where he made rubber toys, rubberised cloth and bandages, and sold table-cloths, covers and rubber shoes.

In 1838 he joined forces with Nathaniel Hayward, a worker in the rubber industry who had experimented with rubber admixed with sulphur by dissolving the latter in turpentine. In 1839 Hayward took out a patent on this sulphur-treatment for eliminating the tacky nature of raw rubber, assigning the rights to Goodyear.

Oil of turpentine was, incidentally, a popular solvent until Macintosh (of whom more later) showed the value of coal-tar naphtha.

As early as 1791 a process of Samuel Peal's specified rubber dissolved in turpentine for waterproofing paper, silk, and leather by brushing the solution on to the fabric. In 1832 Ludersdorff in Berlin was championing the cause of such turpentine solutions for improving the properties of *Gummi Elasticum*. Yet another solvent for rubber was used by a London pharmacist named Winch, this being pure ether, as distinct from the vitriolic ether then common. Winch, like others in the medical field, foresaw the value of rubber for making tubes and elastic catheters as well as rubber gloves.

Yet apart from this early development of rubber solutions, Goodyear goes down in history as discoverer of vulcanising by an accident which should have brought him fortune. In 1839 he was arguing with some of his employees when he accidentally dropped a rubber-sulphur mix on to a hot stove, found the resulting product to be cured or hardened, and vulcanising was born.

He had spent all his resources on experimenting, had no money to take out a patent, and could only 'deposit a claim

CHEMICALS AND BY-PRODUCTS

for record ' with the U.S. Patent Office in 1841. He did not apply for a patent until 1843, while seeking to negotiate with Macintosh by sending samples to him of cured rubber, without disclosing his process. Although he did not discover vulcanising, but only anticipated it after examining samples, Hancock, Macintoshes partner, was such a versatile experimenter that Goodyear's patent rights could only apply to Scotland, a country omitted by Hancock in his rival patent.

As a result of litigation Goodyear's group had to come to terms with Macintosh, who granted an exclusive licence to the American group for importing rubber overshoes, their main object. Hancock's patent for vulcanising was upheld in the courts. He had experimented on rubber and sulphur combined by use of hot turpentine, and had then gone on to molten sulphur and other variations in his series of experiments.

Between 1820 and 1847 Hancock took out 16 patents for working rubber and made important contributions to rubber technology. One of these was his masticator with its revolving knives, the heat evolved during cutting causing the necessary adhesion.

While the Goodyear centenary will be commemorated by reviews of his prolonged work in rubber technology, one other chapter in rubber history should be included since American biographies almost ignore it. This concerns Charles Macintosh and his successful adoption of rubber in waterproofing, a success gained by a chemist seeking to find new outlets for products from the gas industry. Macintosh, like his father, was a leading Scottish chemical manufacturer, his name appearing again and again in the history of chemical technology. Alum, textile chemicals, cudbear, lead compounds and many other chemicals came from his works, yet one of his most striking achievements was in rubber.

At the Glasgow gasworks Macintosh found opportunities for furthering his interests, while later he enabled J. B. Neilsen to experiment at the works with his scheme for preheating air for the blast in iron-smelting. Hancock and other contemporaries left notes enabling the work of Macintosh to be followed up to success with waterproofing.

Macintosh was very interested in ammonia production, his consumption being so large that he contracted with the Glasgow works to take all their by-products for the sake of the ammonia. It was a period in which tar and ammonia liquor were regarded as a nuisance and were dumped wherever possible. As Hancock put it; ' tar and other liquid products accumulated on their hands in the shape of a most disagreeable and inconvenient nuisance. So Mr. Macintosh, chiefly with a view to production of ammonia used in his manufacture of cudbear, entered into contract for a term of years.'

But in converting tar to pitch ' to suit the purposes of consumers, the essential oil termed naphtha was produced; and the thought came to Macintosh to use this as solvent for caoutchouc or india rubber.' By use of this naphtha Macintosh converted rubber into a waterproof ' varnish, the thickness and consistency of which he could vary according to the quantity of naphtha used.'

Macintosh patented the process for joining two layers of fabric by means of his rubber dissolved in naphtha, working together with H. H. Birley, a director of the Manchester gasworks, who provided some capital for the firm.

In 1821 Charles Macintosh & Company began operations first in Glasgow and later in Manchester, making rubber capes, coats, cushions, beds and lifebuoys. About this time Hancock found tar and pitch could be readily incorporated with rubber, especially by use of his masticator which ensured a saving in the solvents used.

At times he used both naphtha and turpentine as mixed solvent, producing rubber gloves, knee-caps and surgical bands. The quarterly journal of the Royal Institution in 1824 referred also to the value of rubber for making washers for stopcocks, balloons and other articles.

This contribution to rubber technology in which coal-tar naphtha proved such a key material has remained forgotten in texts. Yet it shows that the 1820's were a heyday for Charles Macintosh, his rubberised fabrics being followed in 1825 by a patent for converting malleable iron to steel through the use of coal-gas, and a year later by his furnace for burning tar residues after extracting naphtha. This furnace was adopted by many gasworks throughout the country at a time when, as Birley of the Manchester works put it, ' we are very much plagued in the sale of the tar.'

B.S.I.'s report for 1959-60

THE 1959-1960 report of the British Standards Institution which will be presented at B.S.I.'s annual general meeting on September 28 shows that the 12 months' period to March 31 was a busy and successful one from the standards viewpoint. It was a year of record output with 297 new or revised British Standards published—that is substantially more than one for every working day of the week. There were record sales, too, of nearly 1,100,000 British Standard publications, about one-quarter of which went overseas. The number of subscribing members was also at a peak figure of over 11,000.

The record of ' work-in-hand ' makes it clear that B.S.I.'s range of activities is becoming ever more extensive and suggests that in the coming year or two the output of standards will be at least as high as in the year under review. The report strikes a warning note, however. As B.S.I.'s burden becomes heavier ' an accelerated rise in subscriptions and income generally will be necessary if B.S.I. is to carry out its basic work with proper efficiency and if it is to continue and extend the essential related services of promoting the application of standards, helping in education and providing publicity, especially overseas.'

The report refers also to B.S.I.'s new safety standards for domestic oil heaters and for measuring flammability of fabrics.

The number of standards under which the Kite-mark is used rose from 145 to 170, says the report, and increased use had been made of the Kite-mark in newspaper and magazine advertisements.

Reference is also made in the report to the setting up of the new approvals board for domestic electrical appliances, a development in which B.S.I. had taken a leading part together with B.E.A.M.A. and the electricity supply industry.

Copies of the report are available from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. price 7/6. (Postage will be charged extra to non-subscribers).

2000 FRENCH FLATS WILL EMPLOY SE-DUCT

Acceptance in France spreads

NEWS SUPPLEMENT

SE-DUCT installations are now under construction for 2,000 flats in cities throughout the south of France. Of the many countries which showed active interest in the Gas Council's Se-Duct flue system, France has been the most enthusiastic in its adoption, and the number of installations is growing rapidly, particularly in the Southern cities.

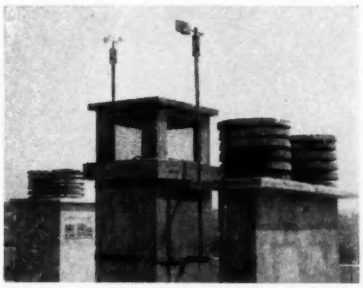
Since mid-1958, Ascot Gas Water Heaters Ltd., has arranged for engineers of Gaz de France and the company of Chaffoteaux et Maury to visit various sites and to discuss the Se-Duct with the South Eastern Gas Board laboratories and True-Flue Ltd. As a result, a large block of flats incorporating Se-Ducts with central heating boilers was designed for the town of Cholet in the Anjou province of Western France, and an experimental full-scale Se-Duct was erected for research and testing of appliances in the laboratories of Gaz de France at Gennevilliers, near Paris.

Fully instrumented Se-Duct

At Cholet where the ten-storey block of 160 flats is now more than half completed and a quarter occupied, the Se-Ducts serve Chaffoteaux et Maury central heating units which provide both hot water supply and space heating by forced circulation through either radiators or floor coils. One Se-Duct is fully instrumented and under the supervision of Gaz de France personnel is providing continuous records of appliance usage, CO_2 concentration, air temperature and velocity in the vertical duct, and air temperature, wind direction and speed outside at the terminal. This scheme of instrumentation is based on the Gas Council's first instrumented Se-Duct in a similar block of flats at Gateshead, but goes further in that it will provide data on the wind around the terminal.

The arrangements for the entry of air to the Se-Ducts are of particular interest. There are no horizontal ducts as, with the ground floor occupied by freely ventilated storage compartments, it has been possible to have the inlets of the Se-Duct in the form of simple openings in the ceiling. Ventilation openings in the outer walls of the ground floor have been designed in a variety of pleasing architectural forms, some resembling the cannon and archers' slits in the ancient fortress castles of the Anjou province, and others as massive louvres.

At the invitation of the French engineers active in furthering the use of the Se-Duct in France, Mr. J. B. Carne and Mr. T. T. White, of the South Eastern Gas Board, and Mr. R. W. Dudley and Mr. N. W. Rickwood representing Ascot Gas Water Heaters Ltd., recently visited the installations at Gennevilliers and Cholet. At Gennevilliers a Se-Duct version of a Chaffoteaux et Maury central heating boiler combined with a special calorifier was being tested.



The terminal of the instrumented Se-Duct. The shunt terminals are for ventilating internal toilets and for solid fuel appliances.

Swedes choose N.W.G.B. coke

A LARGE Swedish chrome manufacturer, after shopping around Europe and Britain for a special high grade coke with the lowest possible phosphorus content, has placed its contract for coke supplies with the North Western Gas Board.

The firm, Aktiebolaget Ferrolegeringar, possesses at Trollhättan in west Sweden the largest electric arc furnace of its type in Europe. This works manufactures special chrome for high quality chrome steel, and requires a good large coke with an exceedingly low phosphorus content.

The North Western Gas Board was able to offer a coke produced at its Partington and Denton works with a phosphorus content of under 0.001%, thereby winning the contract for 16,000 tons a year in the face of stiff competition from suppliers in Germany and other parts of Britain.

Oil heater makers fulfil pledge of modification

IMPROVED resistance to draught can now be built into radiant heaters by means of do-it-yourself conversion kits. Over 3 mill. heaters now in use can be modified in this way, but the manufacturers of the rest, estimated to number 1½ mill., recommend that their heaters should be returned to them for modification, since their design renders home conversion more difficult.

The conversion kits, now or shortly to be made available by about a dozen leading heater manufacturers, are to cost between 2s. and 30s., and will generally be obtainable direct from the makers. The sets have been developed to fulfil the commitment volunteered to Mr. R. A. Butler, the Home Secretary, earlier this year, concerning improvements for heaters already on the market.

Those heaters which need to be returned to the manufacturers will carry a higher charge for modification—the cost ranges between 30s. and £4. But when modified these heaters would usually be up to the full new British Standard 3300. A number of the manufacturers offering do-it-yourself kits are also prepared to modify heaters up to full British Standard in place of the conversion kit, if owners of the heaters write direct to them.

New Zealand gasholder will be built in U.K.

A CONTRACT for a large gasholder worth about £250,000 for New Zealand, has been secured by Clayton, Son and Co. Ltd., Moor End Works, Hunslet, Leeds. It will take about a year to build the gasholder at Hunslet, and it will then be shipped in sections to the Christchurch Gas Coal and Coke Co. Ltd., in New Zealand, where the firm's supervisor will be in charge of erecting it.

A spokesman for the Leeds company said that members of the firm's outdoor staff travelled overseas periodically to supervise installations, but those in New Zealand were there almost continually because of the amount of work being done by the company in that country.

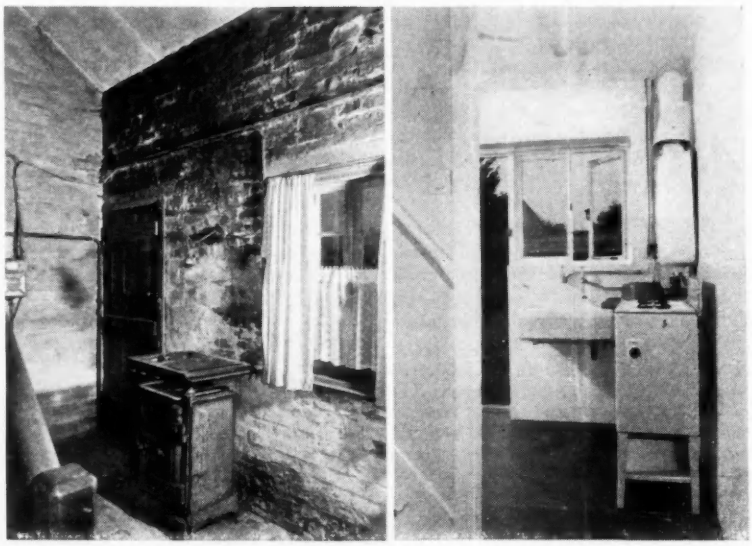
C19th COTTAGES MODERNISE WITH GAS

A MAJOR renovation is now being completed to the 64 cottages which form part of the Thorngate Charitable Trust, at Brockhurst, Hampshire.

The main improvement, apart from modern fireplaces, has been to install bathrooms and separate lavatories in part of the old kitchens which are now smaller, modernised and more compact. To achieve these alterations the kitchens had to be re-designed, including the provision of a new entrance door and placing of the various windows.

The modernisation programme was considered to be worthy of a visit from the Minister of Housing and Local Government, the Right Honourable Henry Brooke, who inspected the first block to be completed and was able to see work in hand on other blocks.

The first ten of the cottages were built by John and William Thorngate in 1866. At a later date William Thorngate built a further group of cottages and instructed his Trustees to build yet more so that there were eventually 64 in all.



A 'before-and-after' effect in the kitchen of one of the Thorngate Trust cottages at Brockhurst, Hampshire, modernised with the co-operation of the Southern Gas Board. Standard equipment in the 64 renovated cottages is the Flavel Imp cooker and Ascot 709 multipoint water heater.

SAHARA GAS FOR GERMANY

NATURAL gas from the Sahara is to be used to supplement present supplies in the Rhineland, the Cologne Gas, Electricity & Water Company announced recently.

Negotiations are proceeding, and the gas will be shipped either to Dutch or west German ports and then piped to Rhineland towns. The first deliveries are not expected before 1966.

Natural gas find at Roma

Canadian and U.S. firms have offered technical help to develop natural gas deposits at Roma, south eastern Queensland. Natural gas is already used at Roma as fuel. A pipe-line technologist is surveying a route for a possible pipeline to carry gas 350 miles to Brisbane.

Those who regard gas and electricity as equal partners in the fuel field must have been gratified by these two 'Moore-ish' figures which dominated the stand of the Ville de Liège Service du Gaz et de l'Electricité at the recent International Trade Fair held in the town.

RoSPA prepares for operation cleansweep

PREPARATIONS are now in hand for the biggest onslaught against untidiness in Britain's factories for nearly ten years. Operation Cleansweep, which forms the central theme of the National Industrial Safety Week, organised by the Royal Society for the Prevention of Accidents (RoSPA), will be mounted during the week beginning September 26 as all kinds of factories everywhere in the country clear away accident-producing accumulations of waste, litter, scrap metal and idle, dusting, derelict plant.

The result of the campaign, if successful, will be the elimination of many dangerous hazards in factories. The removal of situations conducive to tripping, slipping, bumping and falling would result in a reduction of a number of accidents at present forming an ominous group stigmatised by H.M. Chief Inspector of Factories as the 'Big Five.'

This group, which includes such causes officially classified as, 'persons falling,' 'falls of objects,' 'handling goods,' 'stepping on or striking against objects,' and 'use of hand tools,' accounts for nearly 70% of accidents occurring in industrial premises subject to the statutory provisions of the Factories Acts.

Predominant amongst the publicity material devised for the campaign by the Society will be a figure called Jack Tidy, who will be present on most of the posters and other devices with the injunction to 'Keep it Shipshape, Mate.'

Dundee gasworks may be forced to close down

DUNDEE gasworks may have to close because of reduced demand for gas, Mr. W. Nicol Baird, General Manager of the Scottish Gas Board's Central Division, has informed Dundee Town Council.

Mr. Baird states that the cost of manufacturing gas in Dundee is now higher than at any other main production centre in the division. 'It is obvious that the Board can obtain considerable economies by closing the Dundee works entirely and by providing a bulk supply of gas from Fife. This would make redundant the 200 employees engaged on gas production in Dundee. Other redundancies would follow inevitably.'

Mr. Baird has appealed to the Town Council to give freedom of choice between gas and electricity to the tenants of Corporation houses. In recent years 75% of new houses in Dundee have been all-electric. The new housing estate of Menzieshill is in the city's first smokeless zone, and the Council's Housing Committee propose to make the 3,400 houses all-electric. Before coming to a final decision, the Housing Committee will compare the cost of gas and electricity for heating.

TWO MEN LIFT 16-TON ENGINE

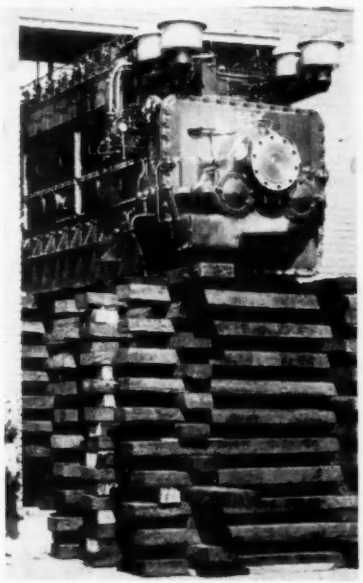
TWO service engineers 'lifted' a 16-ton Blackstone Dual Fuel engine 13-ft., using pulleys, rollers, and hydraulic jacks, to get it into position recently at the Llanelly gasworks after delivery.

The 16-cylinder diesel engine, a Blackstone EVDF 16, is being used to drive a Bryan Donkin Compressor for the South Wales gas grid; who already have an 8-cylinder Blackstone engine in operation at their Llanelly works.

The problem facing the Blackstone service engineers, who brought the engine by low-loader from their Stamford, Lincs., factory, was raising the engine onto a 13-ft. high plinth inside the compressor house: Too awkward a job for them to make use of the cranes available.

Making use of materials at hand they decided to lift the massive engine on railway sleepers, accomplishing the manouvre with the help of two hydraulic jacks.

Having unloaded the engine at the base of the compressor house the first operation entailed raising it to the 'step' at floor level. The engine was raised from the ground, one side at a time, then back and front, with a sleeper inserted on each lift. On floor level the engine was 'rolled' half-way into the house; and the cumbersome lifting operation continued: Sleeper by sleeper.

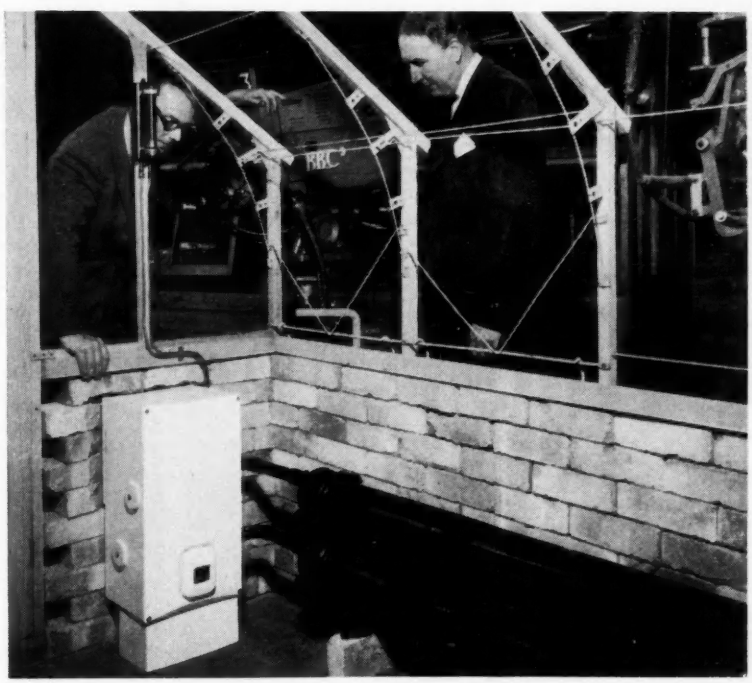


The installation of the Blackstone EVDF 16 at the Llanelly gasworks. The engine was raised on railway sleepers a total of 13 ft. onto a plinth inside the compressor house.

The next stage was to push the engine completely inside the compressor house when the top of the entrance was reached; then, up and up, until the 13-ft. plinth was reached.

It took the two engineers seven working days to get their 16-ton 'problem' into position.

The Dual Fuel Blackstone engines start on straight diesel oil, and then run on the gas—in this case local town gas—most readily available, and up to 10% pilot fuel injection to initiate combustion. The engine at the Llanelly gasworks will operate on 90% local town gas and 10% diesel oil.



Mr. W. Kidman (left), Public Relations Officer, and Mr. H. A. Edkins, Assistant Sales and Service Manager, West Midlands Gas Board, inspecting a balanced-flue type heater that was featured on T.V. last Friday.

B.B.C. T.V. SHOWS GAS-HEATED GREENHOUSE

A GAS-HEATED greenhouse was one of several featured in the popular B.B.C. television programme 'Gardening Club' on August 19.

It was a balanced-flue type of heater fitted in an 8-ft. square house and the completed installation, including thermostat and water pipes, was fitted by the West Midlands Gas Board in the B.B.C.'s Midland Television Studio at Gosta Green, Birmingham.

To fit in with shooting arrangements—the programme was filmed—the equipment had to be installed overnight and taken down again as soon as shooting was completed.

PERSONAL NOTES

DR. R. H. GRIFFITH, Director of Research at the Gas Council's London Research Station, retires from his post at the end of August 1960. He was educated at Magdalen College, Oxford, where he obtained a D.Phil. in 1925. In the same year he joined the Research Laboratory of the Gas Light and Coke Company. During the ensuing 35 years Dr. Griffith has built up a world-wide reputation in the field of catalysis, and has contributed a number of important papers on various aspects of this subject, notably in the Proceedings of the Royal Society. He is also the author of a standard text book on Contact Catalysis and a book, 'The Practice of Research', which describes in detail the functions, structure and organisation of a chemical research department attached to industry.

In 1945 he was appointed senior research chemist to the Gas Light and Coke Company, a position he continued to hold with the North Thames Gas Board after nationalisation. On the retirement of Dr. Hollings in 1952, Dr. Griffith was appointed Controller of Research of the Board and Director of the London Research Station of the Gas Council. He is a Fellow of the Chemical Society and of the Institute of Fuel, a member of the Faraday Society, and has been a member of council of the Institution of Gas Engineers by whom he was awarded the H. E. Jones medal on two occasions.

It is understood that the Gas Council is to review the research activities of the Council shortly, and for the time being MR. HOPTON, Senior Research Chemist, will be responsible for research at the Fulham Laboratories of the London Research Station.

The Minister of Power has appointed PROVOST E. WATT of Dumfries to be a member of the Scottish Gas Consultative Council. Provost Watt has been a member of Dumfries Town Council since 1949 and has experience of most of its committees, particularly Housing and Town Planning. He has also been a member of Dumfries County Council for a number of years and has several times been a magistrate. He was elected Provost in May this year.

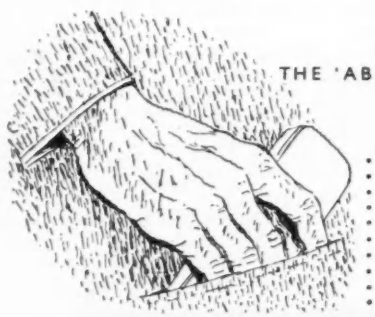
MR. W. K. HUTCHISON, Deputy Chairman of the Gas Council, is among the 18 new members of the 27-strong Clean Air Council. The three-year appointments to the council which was set up in 1957 have expired and Mr. Henry Brooke, Minister of Housing and Local Government, has reconstituted the body. SIR HUGH BEAVER, chairman of the committee, whose report lead to the Clean Air Act, is re-appointed until April 30 next year.

MR. ED PECKHAM, Chairman and Managing Director, and MR. SANDY PAGET, Director of Metalock (Britain) Ltd., London, will be making a three month tour of Sheffield, Huddersfield, Halifax, Bradford, Wakefield, Manchester and Liverpool.

OBITUARY

MR. CHARLES FREDERICK DUTTON has died at the age of 67. Mr. Dutton joined the commercial department of Powell Duffryn in 1909. In the 1914-1918 war he was a Company Commander in the South Wales Borderers and was decorated with the M.C. and Bar. After the war he returned to Powell Duffryn and eventually became by-products sales manager.

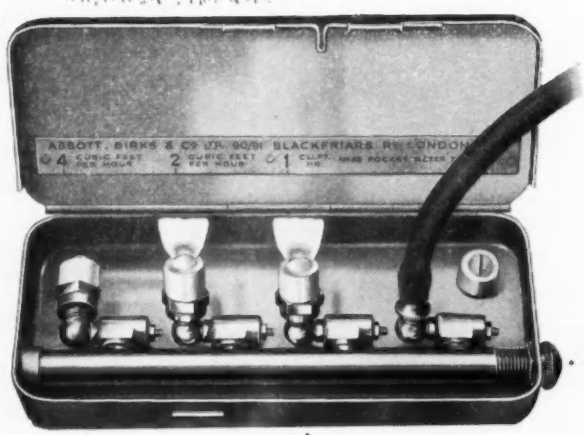
He joined the National Coal Board as assistant director of marketing (by-products) when the coal industry was nationalised, and retired from that position on January 31 this year. He took a prominent part in the affairs of the various by-product associations, and was president of the Association of Tar Distillers in 1957-58, a vice-president of the British Sulphate of Ammonia Federation, a member of the Executive and Finance Committees of the British Tar Confederation and of the British Road Tar Association.



THE 'ABBIRKO'

Pocket Meter Tester

FOR DETECTING (IN SITU) THE PASSAGE OF UNREGISTERED GAS AT LOW CONSUMPTION



Now that nearly every home has either a refrigerator or a heater with pilot light, unregistered gas can be an important source of lost revenue. This handy instrument permits the quick routine inspection of meters *in situ* to ensure that they are registering at low consumption.

With its three governed burners, meters can be checked at consumptions of 1, 2, 3, 4, 5, 6, and 7 cu. ft./hr.—a range to cover meters from the small domestic to the large industrial type.

Full particulars on request.

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